I. PATENT ABSTRACTS OF JAPAN

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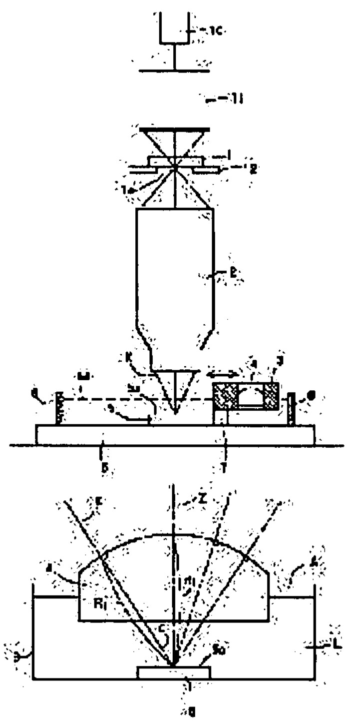
(71)Applicant : **NIKON CORP**
(72)Inventor : **FUJISHIMA YOHEI**
MATSUMOTO KOICHI

(54) PROJECTION ALIGNER AND EXPOSURE METHOD



(57)Abstract:
PROBLEM TO BE SOLVED: To provide a projection aligner and method for reducing the change of image forming performance at an image forming position and in the neighborhood of an optical axis in a projection optical system, even when this projection optical system is used in an immersion state compared with the case that the projection optical system is used in a normal state.
SOLUTION: This projection aligner is provided with a projection optical system 2 for transferring a pattern 1a plotted on an original art 1 to a photosensitive face 5a of a substrate 5. An auxiliary lens 4 is arranged so as to be inserted into and pulled out of a space between the lens face at the substrate 5 side of the projection optical system 2 and the photosensitive face 5a, and a space between the lower face of the auxiliary lens 4 and the photosensitive face 5a is formed to be immersion possible. Also, a curvature radius R1 of the lens face at the original art 1 side of the auxiliary lens 4 is formed, so as to be almost equal to a distance d1 on an optical axis Z from the lens face at the original art 1 side to the photosensitive face 5a.

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CLAIMS

[Claim(s)]

[Claim 1] In the projection aligner which has the projection optical system which imprints the pattern drawn on the original edition to the sensitization side of a substrate Said projection optical system is arranged most possible [insertion and detachment of an attachment lens] in the space of the lens side by the side of a substrate, and said sensitization side. The space of the underside of this attachment lens, and said sensitization side It is the projection aligner characterized by having been formed possible [immersion], and forming the radius of curvature of the original edition side lens side of said attachment lens so that it may become almost equal to the distance on the optical axis from this original edition side lens side to said sensitization side.

[Claim 2] The radius of curvature of the substrate side lens side of said attachment lens is a projection aligner according to claim 1 characterized by being formed so that it may become almost equal to the distance on the optical axis from this substrate side lens side to said sensitization side.

[Claim 3] It is the projection aligner characterized by being formed in the projection aligner which has the projection optical system which imprints the pattern drawn on the original edition to the sensitization side of a substrate so that said projection optical system may become almost the equal to the distance on the optical axis from the lens side by the side of this substrate to said sensitization side as for the radius of curvature of the lens side by the side of a substrate.

[Claim 4] The exposure approach characterized by including the lighting process which illuminates said original edition with a predetermined exposure light, and the exposure process which exposes the pattern image of said original edition to the sensitization side of said substrate through said projection optical system in the approach of exposing using the projection aligner of a publication in any 1 term of claim 1 thru/or claim 3.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the projection aligner and the exposure approach of having the projection optical system which carries out the printing imprint of the pattern drawn on the original edition on a substrate.
[0002]
[Description of the Prior Art] In recent years, detailed-ization of the pattern imprinted by the wafer as a photosensitive substrate is desired. In order to attain this, two approaches, or [whether short wavelength-ization of exposure wavelength is attained or / attaining buildup-ization of the numerical aperture of a projection optical system], can be considered. Before, the immersion-type projection aligner is proposed as an approach of attaining buildup-ization of the numerical aperture of a projection optical system among these. An immersion-type projection aligner is equipment of a projection optical system which fills space (it is henceforth called actuation space.) all of the lens side by the side of a wafer and space with a wafer, i.e., the working distance, (working distance), or the subspace by the side of a wafer with liquids, such as an oil, most. Usually, as opposed to the refractive index of the air which occupies the actuation space at the time of an activity being 1.0, the refractive index of an oil is about 1.6. For this reason, if all of actuation space or the subspace by the side of a wafer is permuted by the liquid with a refractive index high in this way, numerical aperture by the side of the wafer of a projection optical system can be enlarged, and detailed-ization of an exposure pattern can be attained.
[0003]
[Problem(s) to be Solved by the Invention] In the above-mentioned conventional immersion-type projection aligner, it is with the time of the immersion [which makes actuation space gases, such as air] activity which attains the time of an activity, and detailed-ization of a pattern, and uses all of actuation space, or subspace by the side of a wafer as a liquid, and the equivalent image formation engine performance was not usually able to be secured. For example, the case where parallel plate glass is installed in the boundary of a gas and a liquid is considered as operation at the time of the immersion which uses wafer flank part space of actuation space as a liquid. In such a case, the following three nonconformities occur.
[0004] The 1st is nonconformity from which the image formation location by the projection optical system shifts by the optical refraction in the plane of incidence of parallel plate glass at the time of an immersion activity. Therefore, it is necessary to move a projection optical system or a wafer so that a focal distance may be secured. And depending on the conditions at the time of the immersion activity, an image formation location may not no longer be doubled on a wafer. The 2nd is nonconformity which spherical aberration produces with the parallel plate glass installed in the boundary of a gas and a liquid at the time of an immersion activity. By this, the image formation engine performance worsens at the time of an immersion activity. The 3rd is nonconformity to which change of the image formation engine performance at the time of an immersion activity or an image formation location becomes large by the environmental variation. That is, since the refractive index of a liquid changes with environmental variations, such as a temperature change, a lot compared with a gaseous refractive index, neither the image formation engine performance nor an image formation location is stabilized by it. Therefore, this invention makes it a technical problem to offer the image formation location by the projection optical system, a projection aligner with little change of the image formation engine performance near

an optical axis, and the exposure approach compared with the case where it is used by the normal state, even when a projection optical system is used in the state of immersion.

[0005]

[Means for Solving the Problem] When the sign which it was made in order that this invention might solve the above-mentioned technical problem, namely, was given to drawing 1 and drawing 2 of an accompanying drawing is written in addition in a parenthesis, this invention In the projection aligner which has the projection optical system (2) which imprints the pattern (1a) drawn on the original edition (1) to the sensitization side (5a) of a substrate (5) A projection optical system (2) is arranged most possible [insertion and detachment of an attachment lens (4)] in the space of the lens side by the side of a substrate (5), and a sensitization side (5a). The space of the underside of an attachment lens (4), and a sensitization side (5a) It is the projection aligner characterized by having been formed possible [immersion], and forming the radius of curvature (R1) of the original edition (1) side lens side of an attachment lens (4) so that it may become almost equal to the distance (d1) on the optical axis (Z) from the original edition (1) side lens side to a sensitization side (5a). When the sign further given to drawing 3 of an accompanying drawing is written in addition in a parenthesis in that case, as for the radius of curvature (R2) of the substrate (5) side lens side of an attachment lens (4), it is desirable to be formed so that it may become almost equal to the distance (d2) on the optical axis (Z) from the substrate (5) side lens side to a sensitization side (5a).

[0006] Moreover, this invention will be set to the projection aligner which has the projection optical system (2) which imprints the pattern (1a) drawn on the original edition (1) to the sensitization side (5a) of a substrate (5), if the sign given to drawing 1 and drawing 4 of an accompanying drawing is written in addition in a parenthesis. It is the projection aligner characterized by being formed so that a projection optical system (2) may become almost the equal to the distance (d2) on the optical axis (Z) from the lens side by the side of a substrate (5) to a sensitization side (5a) as for the radius of curvature (R2) of the lens side by the side of a substrate (5). Moreover, this invention is the exposure approach characterized by to include the lighting process which illuminates the original edition (1) with a predetermined exposure light, and the exposure process which exposes the pattern image (1a) of the original edition (1) to the sensitization side (5a) of a substrate (5) through a projection optical system (2) in the approach of exposing using the projection aligner of an above-mentioned configuration, when the sign given to drawing 1 of an accompanying drawing writes in addition in a parenthesis.

[0007]

[Embodiment of the Invention] A drawing explains the gestalt of operation of this invention. Drawing 1 and drawing 2 show the 1st example of the projection aligner by this invention. Drawing 1 is drawing by the 1st example of this invention usually showing the projection aligner in the time of an activity. **** 1 example carries out image formation of the image of pattern side 1a of reticle 1 to image surface 5a (sensitization side) of a wafer 5 by the exposure approach including a lighting process and an exposure process. That is, the flux of light emitted from the light sources 10, such as a KrF excimer laser, illuminates to homogeneity pattern side 1a of the reticle 1 as the original edition laid on the reticle stage 12 through the illumination-light study system 11. The exposure light emitted from pattern side 1a of reticle 1 carries out image formation of the image of pattern side 1a to image surface 5a of the wafer 5 laid on X-Y stage 8 through a projection optical system 2. In addition, at the time of an activity, actuation space usually says the condition of only air.

[0008] Here, on X-Y stage 8, a revolving shaft 7 is intervened and the attachment lens 4 held at

the lens holder 3 is installed. This attachment lens 4 is pivotable centering on a revolving shaft 7. And if 180 degrees rotates from the location shown in drawing 1 , an attachment lens 4 will be arranged just under a projection optical system 2. At this time, the optical axis of an attachment lens 4 is in agreement with the optical axis of a projection optical system 2. Moreover, the cube type-like liquid shield 6 is installed on X-Y stage 8. By drawing 1 , since it is easy, only the cross section of the liquid shield 6 is shown. And liquids, such as an oil, can be put into the space surrounded by the liquid shield 6, and space can be used as a liquid by wafer 5 flank of actuation space. When using the projection aligner of **** 1 example in the state of immersion, an attachment lens 4 is arranged just under a projection optical system 2, and a liquid is put in in the liquid shield 6. At this time, it becomes air between the top face (field by the side of reticle 1) of an attachment lens 4, and the underside (most field by the side of a wafer 5) of a projection optical system 2. And it becomes a liquid between the underside (field by the side of a wafer 5) of an attachment lens 4, and a wafer 5. The broken line M of drawing 1 shows air and the borderline of a liquid.

[0009] Drawing 2 is drawing in which it was expanded and shown near the attachment lens 4 in the projection aligner in the time of the immersion activity by the 1st example of this invention. As mentioned above, in the time of an immersion activity, the space by the side of the top face of an attachment lens 4 serves as Air A, and the space by the side of the underside of an attachment lens 4 serves as Liquid L. Moreover, the refractive index of the attachment lens 4 in **** 1 example serves as a value almost equal to the refractive index of Liquid L. The top-face configuration of an attachment lens 4 is the configuration in which all the beams of light K that carry out image formation to the core of image surface 5a on a wafer 5 carry out incidence vertically. That is, an attachment lens 4 and Liquid L twist, and the center of curvature of the top face of an attachment lens 4 is usually in agreement with the core of image surface 5a at the time of an activity. And the radius of curvature R1 of the top face of an attachment lens 4 fills a degree type.

R1=d1 (1)

d1: Distance on the optical axis Z from attachment lens 4 top face to wafer image surface 5a

[0010] On the other hand, the underside configuration of an attachment lens 4 is a flat-surface configuration. As mentioned above, since the refractive index of an attachment lens 4 and Liquid L is equal, no beams of light K which carry out image formation near the core of image surface 5a are almost refracted like the top-face section also in the underside section of an attachment lens 4. Therefore, the convergence half width at the time of an immersion activity usually becomes equal to the convergence half width at the time of an activity. The refractive index [as opposed to / at this time / the air of a NA=nsinthetan:liquid in the numerical aperture NA by the side of the wafer 5 of a projection optical system 2] theta: It can be found in convergence half width. Moreover, resolution delta r can be found in a degree type.

The refractive index k in the inside of the air of deltar=klambda0/NAlambda0:exposure light: Constant [0011] Therefore, compared with the time of an activity, resolution [in / for numerical aperture / n times and near an image surface 5a core] can usually be improved to 1/n at the time of an immersion activity. Moreover, in the **** 1 example, since all the beams of light K that carry out image formation to the core of image surface 5a are not refracted depending on an attachment lens 4, spherical aberration does not generate them. Furthermore, when the chromatism of an attachment lens 4 and the chromatism of Liquid L are equal, axial overtone aberration is not generated, either. Thereby, in image surface 5a near optical-axis Z, even if it is at the immersion activity time, the image formation engine performance at the time of an activity

is usually maintained mostly. Furthermore, there are not the time of an immersion activity and change of the image formation location usually according to a projection optical system 5 by the time of an activity, either.
[0012] Next, drawing 3 shows the 2nd example of the projection aligner by this invention. **** 2 example differs only in the configuration of an attachment lens 4 from said 1st example. Drawing 3 is drawing in which it was expanded and shown near the attachment lens 4 in the projection aligner in the time of the immersion activity by the 2nd example of this invention. The configuration of the top-face section of the attachment lens 4 of **** 2 example is equal to the configuration of the top-face section of the attachment lens 4 of said 1st example. That is, the relation of (1) type is realized in the top-face section.
[0013] On the other hand, the configuration of the underside section of the attachment lens 4 of **** 2 example is a curved-surface configuration to the underside section of the attachment lens 4 of said 1st example being a flat-surface configuration. And the underside configuration is the configuration in which all the beams of light K that carry out image formation to the core of image surface 5a on a wafer 5 carry out incidence vertically like a top-face configuration. That is, the center of curvature of the underside of an attachment lens 4 is usually in agreement with the core of image surface 5a at the time of an activity. And the radius of curvature R2 of the underside of an attachment lens 4 fills a degree type.
R2=d2 (2)
d2: Distance on the optical axis Z from attachment lens 4 underside to wafer image surface 5a
[0014] According to **** 2 example, even if it is a time of the refractive indexes of an attachment lens 4 and Liquid L differing, and a time of the refractive index of Liquid L changing with environmental variations, such as a temperature change, there is little change of aberration or an image formation location. That is, on the underside of an attachment lens 4, no beam of light K of the wavelength which carries out image formation to the core of image surface 5a is concerned with the refractive index and chromatism of Liquid L, and is not refracted. Therefore, also in **** 2 example, high resolution can be obtained like said 1st example at the time of an immersion activity. Moreover, even if it usually compares the time of an activity and an immersion activity, the image formation location by the projection optical system 2 does not change, but there is also no change of the axial overtone aberration in image surface 5a or spherical aberration, and the image formation engine performance in image surface 5a near optical-axis Z is maintained. Furthermore, even if the refractive index of Liquid L changes with temperature changes etc., there is no change of an image formation location, axial overtone aberration, or spherical aberration.
[0015] Next, drawing 4 shows the 3rd example of the projection aligner by this invention. Although a part of space was used as the liquid by wafer 5 flank of actuation space in said 1st and 2nd example at the time of an immersion activity, let all of actuation space be a liquid in the **** 3 example at the time of an immersion activity. namely, -- the time of an immersion activity -- a projection optical system 2 -- the field by the side of a wafer 5 will be most dipped in a liquid. Therefore, the projection aligner of **** 3 example must have the top face of the liquid shield 6 of drawing 1 higher than the underside of a projection optical system 2. Furthermore, the lens holder 3 of drawing 1 used at the time of the immersion activity of said 1st and 2nd example, an attachment lens 4, and a revolving shaft 7 become unnecessary.
[0016] Drawing 4 is drawing of the projection optical system 2 of a projection aligner having expanded and shown the field by the side of a wafer 5 most at the time of an immersion activity. a projection optical system 2 -- the configuration of the field by the side of a wafer 5 is the equal

to the configuration of the underside section of the attachment lens 4 of said 2nd example. That is, the relation of (2) types is realized in the underside section. Although the projection optical system 2 shown in drawing 4 will usually be used on the other hand at the time of an activity, no refraction of beams of light K which carries out image formation near the core of image surface 5a is produced like the time of an immersion activity. Also in **** 3 example, high resolution can be obtained like said 2nd example at the time of an immersion activity. Moreover, even if it usually compares the time of an activity and an immersion activity, the image formation location by the projection optical system 2 does not change, but there is also no change of the axial overtone aberration in image surface 5a or spherical aberration, and the image formation engine performance in image surface 5a near optical-axis Z is maintained. Furthermore, even if the refractive index of Liquid L changes with temperature changes etc., there is no change of an image formation location, axial overtone aberration, or spherical aberration.
[0017]
[Effect of the Invention] By this invention, a projection aligner can be shared with a normal state in the state of immersion as mentioned above. And the projection aligner from which the image formation engine performance an image formation location and near an optical axis hardly changes at the time of an immersion activity can be offered. Furthermore, few projection aligners and the exposure approach of the effect of change of a refractive index of a liquid can be offered.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention relates to the projection aligner and the exposure approach of having the projection optical system which carries out the printing imprint of the pattern drawn on the original edition on a substrate.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, detailed-ization of the pattern imprinted by the wafer as a photosensitive substrate is desired. In order to attain this, two approaches, or [whether short wavelength-ization of exposure wavelength is attained or / attaining buildup-ization of the numerical aperture of a projection optical system], can be considered. Before, the immersion-type projection aligner is proposed as an approach of attaining buildup-ization of the numerical aperture of a projection optical system among these. An immersion-type projection aligner is equipment of a projection optical system which fills space (it is henceforth called actuation space.) all of the lens side by the side of a wafer and space with a wafer, i.e., the working

distance, (working distance), or the subspace by the side of a wafer with liquids, such as an oil, most. Usually, as opposed to the refractive index of the air which occupies the actuation space at the time of an activity being 1.0, the refractive index of an oil is about 1.6. For this reason, if all of actuation space or the subspace by the side of a wafer is permuted by the liquid with a refractive index high in this way, numerical aperture by the side of the wafer of a projection optical system can be enlarged, and detailed-ization of an exposure pattern can be attained.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] By this invention, a projection aligner can be shared with a normal state in the state of immersion as mentioned above. And the projection aligner from which the image formation engine performance an image formation location and near an optical axis hardly changes at the time of an immersion activity can be offered. Furthermore, few projection aligners and the exposure approach of the effect of change of a refractive index of a liquid can be offered.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] In the above-mentioned conventional immersion-type projection aligner, it is with the time of the immersion [which makes actuation space gases, such as air] activity which attains the time of an activity, and detailed-ization of a pattern, and uses all of actuation space, or subspace by the side of a wafer as a liquid, and the equivalent image formation engine performance was not usually able to be secured. For example, the case where parallel plate glass is installed in the boundary of a gas and a liquid is considered as operation at the time of the immersion which uses wafer flank part space of actuation space as a liquid. In such a case, the following three nonconformities occur.
[0004] The 1st is nonconformity from which the image formation location by the projection optical system shifts by the optical refraction in the plane of incidence of parallel plate glass at the time of an immersion activity. Therefore, it is necessary to move a projection optical system or a wafer so that a focal distance may be secured. And depending on the conditions at the time of the immersion activity, an image formation location may not no longer be doubled on a wafer. The 2nd is nonconformity which spherical aberration produces with the parallel plate glass installed in the boundary of a gas and a liquid at the time of an immersion activity. By this, the image formation engine performance worsens at the time of an immersion activity. The 3rd is nonconformity to which change of the image formation engine performance at the time of an immersion activity or an image formation location becomes large by the environmental variation. That is, since the refractive index of a liquid changes with environmental variations, such as a

temperature change, a lot compared with a gaseous refractive index, neither the image formation engine performance nor an image formation location is stabilized by it. Therefore, this invention makes it a technical problem to offer the image formation location by the projection optical system, a projection aligner with little change of the image formation engine performance near an optical axis, and the exposure approach compared with the case where it is used by the normal state, even when a projection optical system is used in the state of immersion.

[Translation done.]

MEANS

[Means for Solving the Problem] When the sign which it was made in order that this invention might solve the above-mentioned technical problem, namely, was given to drawing 1 and drawing 2 of an accompanying drawing is written in addition in a parenthesis, this invention In the projection aligner which has the projection optical system (2) which imprints the pattern (1a) drawn on the original edition (1) to the sensitization side (5a) of a substrate (5) A projection optical system (2) is arranged most possible [insertion and detachment of an attachment lens (4)] in the space of the lens side by the side of a substrate (5), and a sensitization side (5a). The space of the underside of an attachment lens (4), and a sensitization side (5a) It is the projection aligner characterized by having been formed possible [immersion], and forming the radius of curvature (R1) of the original edition (1) side lens side of an attachment lens (4) so that it may become almost equal to the distance (d1) on the optical axis (Z) from the original edition (1) side lens side to a sensitization side (5a). When the sign further given to drawing 3 of an accompanying drawing is written in addition in a parenthesis in that case, as for the radius of curvature (R2) of the substrate (5) side lens side of an attachment lens (4), it is desirable to be formed so that it may become almost equal to the distance (d2) on the optical axis (Z) from the substrate (5) side lens side to a sensitization side (5a).
[0006] Moreover, this invention will be set to the projection aligner which has the projection optical system (2) which imprints the pattern (1a) drawn on the original edition (1) to the sensitization side (5a) of a substrate (5), if the sign given to drawing 1 and drawing 4 of an accompanying drawing is written in addition in a parenthesis. It is the projection aligner characterized by being formed so that a projection optical system (2) may become almost the equal to the distance (d2) on the optical axis (Z) from the lens side by the side of a substrate (5) to a sensitization side (5a) as for the radius of curvature (R2) of the lens side by the side of a substrate (5). Moreover, this invention is the exposure approach characterized by to include the lighting process which illuminates the original edition (1) with a predetermined exposure light, and the exposure process which exposes the pattern image (1a) of the original edition (1) to the sensitization side (5a) of a substrate (5) through a projection optical system (2) in the approach of exposing using the projection aligner of an above-mentioned configuration, when the sign given to drawing 1 of an accompanying drawing writes in addition in a parenthesis.
[0007]
[Embodiment of the Invention] A drawing explains the gestalt of operation of this invention. Drawing 1 and drawing 2 show the 1st example of the projection aligner by this invention.

Drawing 1 is drawing by the 1st example of this invention usually showing the projection aligner in the time of an activity. **** 1 example carries out image formation of the image of pattern side 1a of reticle 1 to image surface 5a (sensitization side) of a wafer 5 by the exposure approach including a lighting process and an exposure process. That is, the flux of light emitted from the light sources 10, such as a KrF excimer laser, illuminates to homogeneity pattern side 1a of the reticle 1 as the original edition laid on the reticle stage 12 through the illumination-light study system 11. The exposure light emitted from pattern side 1a of reticle 1 carries out image formation of the image of pattern side 1a to image surface 5a of the wafer 5 laid on X-Y stage 8 through a projection optical system 2. In addition, at the time of an activity, actuation space usually says the condition of only air.

[0008] Here, on X-Y stage 8, a revolving shaft 7 is intervened and the attachment lens 4 held at the lens holder 3 is installed. This attachment lens 4 is pivotable centering on a revolving shaft 7. And if 180 degrees rotates from the location shown in drawing 1 , an attachment lens 4 will be arranged just under a projection optical system 2. At this time, the optical axis of an attachment lens 4 is in agreement with the optical axis of a projection optical system 2. Moreover, the cube type-like liquid shield 6 is installed on X-Y stage 8. By drawing 1 , since it is easy, only the cross section of the liquid shield 6 is shown. And liquids, such as an oil, can be put into the space surrounded by the liquid shield 6, and space can be used as a liquid by wafer 5 flank of actuation space. When using the projection aligner of **** 1 example in the state of immersion, an attachment lens 4 is arranged just under a projection optical system 2, and a liquid is put in in the liquid shield 6. At this time, it becomes air between the top face (field by the side of reticle 1) of an attachment lens 4, and the underside (most field by the side of a wafer 5) of a projection optical system 2. And it becomes a liquid between the underside (field by the side of a wafer 5) of an attachment lens 4, and a wafer 5. The broken line M of drawing 1 shows air and the borderline of a liquid.

[0009] Drawing 2 is drawing in which it was expanded and shown near the attachment lens 4 in the projection aligner in the time of the immersion activity by the 1st example of this invention. As mentioned above, in the time of an immersion activity, the space by the side of the top face of an attachment lens 4 serves as Air A, and the space by the side of the underside of an attachment lens 4 serves as Liquid L. Moreover, the refractive index of the attachment lens 4 in **** 1 example serves as a value almost equal to the refractive index of Liquid L. The top-face configuration of an attachment lens 4 is the configuration in which all the beams of light K that carry out image formation to the core of image surface 5a on a wafer 5 carry out incidence vertically. That is, an attachment lens 4 and Liquid L twist, and the center of curvature of the top face of an attachment lens 4 is usually in agreement with the core of image surface 5a at the time of an activity. And the radius of curvature R1 of the top face of an attachment lens 4 fills a degree type.

$R1=d1$ (1)

d1: Distance on the optical axis Z from attachment lens 4 top face to wafer image surface 5a

[0010] On the other hand, the underside configuration of an attachment lens 4 is a flat-surface configuration. As mentioned above, since the refractive index of an attachment lens 4 and Liquid L is equal, no beams of light K which carry out image formation near the core of image surface 5a are almost refracted like the top-face section also in the underside section of an attachment lens 4. Therefore, the convergence half width at the time of an immersion activity usually becomes equal to the convergence half width at the time of an activity. The refractive index [as opposed to / at this time / the air of a NA=nsinthetan:liquid in the numerical aperture NA by the

side of the wafer 5 of a projection optical system 2] theta: It can be found in convergence half width. Moreover, resolution delta r can be found in a degree type.
The refractive index k in the inside of the air of deltar=klambda0/NAlambda0:exposure light: Constant [0011] Therefore, compared with the time of an activity, resolution [in / for numerical aperture / n times and near an image surface 5a core] can usually be improved to 1/n at the time of an immersion activity. Moreover, in the **** 1 example, since all the beams of light K that carry out image formation to the core of image surface 5a are not refracted depending on an attachment lens 4, spherical aberration does not generate them. Furthermore, when the chromatism of an attachment lens 4 and the chromatism of Liquid L are equal, axial overtone aberration is not generated, either. Thereby, in image surface 5a near optical-axis Z, even if it is at the immersion activity time, the image formation engine performance at the time of an activity is usually maintained mostly. Furthermore, there are not the time of an immersion activity and change of the image formation location usually according to a projection optical system 5 by the time of an activity, either.
[0012] Next, drawing 3 shows the 2nd example of the projection aligner by this invention. **** 2 example differs only in the configuration of an attachment lens 4 from said 1st example. Drawing 3 is drawing in which it was expanded and shown near the attachment lens 4 in the projection aligner in the time of the immersion activity by the 2nd example of this invention. The configuration of the top-face section of the attachment lens 4 of **** 2 example is equal to the configuration of the top-face section of the attachment lens 4 of said 1st example. That is, the relation of (1) type is realized in the top-face section.
[0013] On the other hand, the configuration of the underside section of the attachment lens 4 of **** 2 example is a curved-surface configuration to the underside section of the attachment lens 4 of said 1st example being a flat-surface configuration. And the underside configuration is the configuration in which all the beams of light K that carry out image formation to the core of image surface 5a on a wafer 5 carry out incidence vertically like a top-face configuration. That is, the center of curvature of the underside of an attachment lens 4 is usually in agreement with the core of image surface 5a at the time of an activity. And the radius of curvature R2 of the underside of an attachment lens 4 fills a degree type.
R2=d2 (2)
d2: Distance on the optical axis Z from attachment lens 4 underside to wafer image surface 5a
[0014] According to **** 2 example, even if it is a time of the refractive indexes of an attachment lens 4 and Liquid L differing, and a time of the refractive index of Liquid L changing with environmental variations, such as a temperature change, there is little change of aberration or an image formation location. That is, on the underside of an attachment lens 4, no beam of light K of the wavelength which carries out image formation to the core of image surface 5a is concerned with the refractive index and chromatism of Liquid L, and is not refracted. Therefore, also in **** 2 example, high resolution can be obtained like said 1st example at the time of an immersion activity. Moreover, even if it usually compares the time of an activity and an immersion activity, the image formation location by the projection optical system 2 does not change, but there is also no change of the axial overtone aberration in image surface 5a or spherical aberration, and the image formation engine performance in image surface 5a near optical-axis Z is maintained. Furthermore, even if the refractive index of Liquid L changes with temperature changes etc., there is no change of an image formation location, axial overtone aberration, or spherical aberration.
[0015] Next, drawing 4 shows the 3rd example of the projection aligner by this invention.

Although a part of space was used as the liquid by wafer 5 flank of actuation space in said 1st and 2nd example at the time of an immersion activity, let all of actuation space be a liquid in the **** 3 example at the time of an immersion activity. namely, -- the time of an immersion activity -- a projection optical system 2 -- the field by the side of a wafer 5 will be most dipped in a liquid. Therefore, the projection aligner of **** 3 example must have the top face of the liquid shield 6 of drawing 1 higher than the underside of a projection optical system 2. Furthermore, the lens holder 3 of drawing 1 used at the time of the immersion activity of said 1st and 2nd example, an attachment lens 4, and a revolving shaft 7 become unnecessary.

[0016] Drawing 4 is drawing of the projection optical system 2 of a projection aligner having expanded and shown the field by the side of a wafer 5 most at the time of an immersion activity. a projection optical system 2 -- the configuration of the field by the side of a wafer 5 is the equal to the configuration of the underside section of the attachment lens 4 of said 2nd example. That is, the relation of (2) types is realized in the underside section. Although the projection optical system 2 shown in drawing 4 will usually be used on the other hand at the time of an activity, no refraction of beams of light K which carries out image formation near the core of image surface 5a is produced like the time of an immersion activity. Also in **** 3 example, high resolution can be obtained like said 2nd example at the time of an immersion activity. Moreover, even if it usually compares the time of an activity and an immersion activity, the image formation location by the projection optical system 2 does not change, but there is also no change of the axial overtone aberration in image surface 5a or spherical aberration, and the image formation engine performance in image surface 5a near optical-axis Z is maintained. Furthermore, even if the refractive index of Liquid L changes with temperature changes etc., there is no change of an image formation location, axial overtone aberration, or spherical aberration.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the projection aligner by the 1st example of this invention.

[Drawing 2] It is drawing showing the condition at the time of the immersion activity of the projection aligner by the 1st example of this invention.

[Drawing 3] It is drawing showing the condition at the time of the immersion activity of the projection aligner by the 2nd example of this invention.

[Drawing 4] It is drawing showing the condition at the time of the immersion activity of the projection aligner by the 3rd example of this invention.

[Description of Notations]

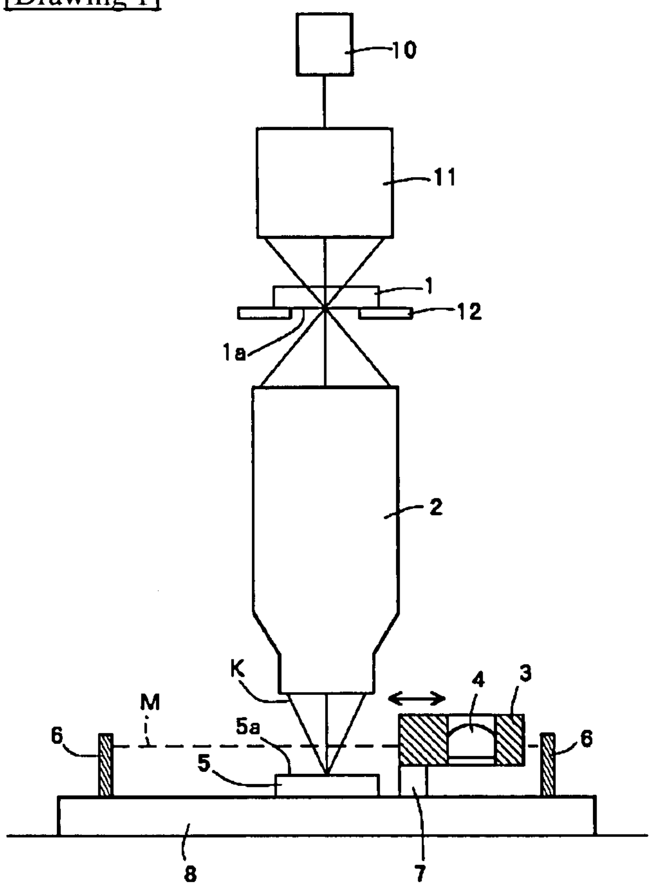
1 -- Reticle 1a -- Pattern side
2 -- Projection optical system
3 -- Lens holder
4 -- Attachment lens
5 -- Wafer 5a -- Image surface
6 -- Liquid shield 7 -- Revolving shaft

8 -- X-Y stage 10 -- Light source
11 -- Illumination-light study system
12 -- Reticle stage
Z -- Optical axis K -- Beam of light
A -- Gas L -- Liquid

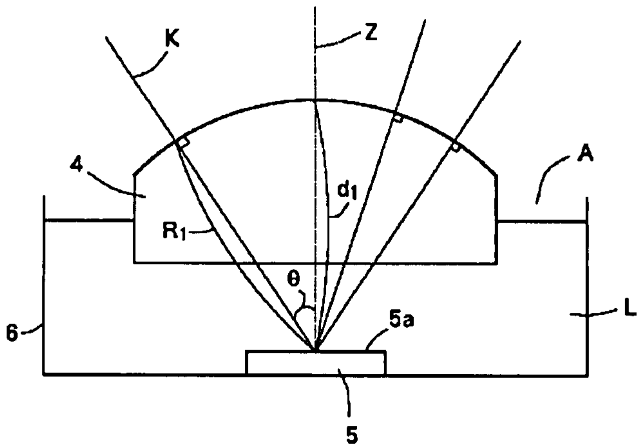
[Translation done.]

DRAWINGS

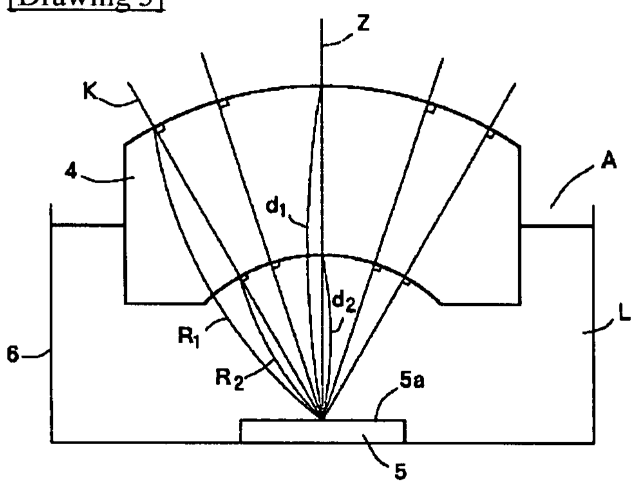
[Drawing 1]



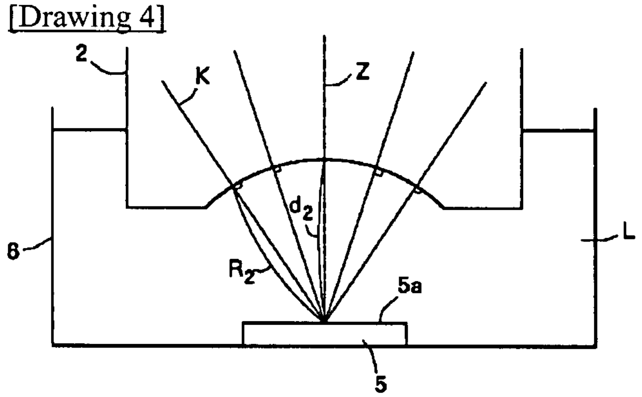
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]